Predicting Mathematics Learning Center Visits: An Examination of Correlating Variables

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Abstract

This study, which explores factors that motivate developmental mathematics students to seek available assistance with their coursework, showed statistically significant correlations between the number of math learning center visits and various variables. An interaction effect was revealed between mathematics confidence and years of college enrollment. The data suggests that younger college students are less inclined to seek mathematics learning center assistance than returning adults and that students with high levels of mathematics confidence are less inclined to proactively seek academic assistance. The data suggests learning center coordinators might consider exploring ways reach out to these targeted areas to develop solid academic skills.

In this era of increasing needs and diminishing resources in developmental education, finding ways to target our efforts to engage students in proactive learning processes is critical. The reality that many college students fail courses without ever seeking assistance through a learning center is frustrating indeed. Can learning center professionals predict which students are likely to visit learning centers? How do factors such as the age and prior college experiences of the student, confidence level and perceived importance of mathematics, current course enrollment and enrollment history correlate with use of a mathematics learning center? Are there interaction effects between any of these variables? This article aims to answer these questions using empirical data.

Background

Research has long suggested favorable connections between peer tutoring and academic success in a variety of disciplines, including college mathematics. Positive associations between consistent peer tutoring, retention, test scores, and grades in mathematics have been established in multiple studies across a wide range of age groups (Gribbons & Dixon,

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2001; Heintz, 1975; Reitz & McCuen, 1993; Sprinthall & Scott, 1989; Xu, Hartman, & Uribe, 2001). The benefits of peer tutoring have even captured the attention of the National Science Foundation. As part of a reform initiative targeting general, organic, and biochemistry, the National Science Foundation has given its support to a peer-guided learning system known as Workshop Chemistry (Lyle & Robinson, 2003).

Studies of the motivating and inhibiting factors affecting mathematics students offer a complicated glimpse of potential tutee motivation. A comprehensive mixed methods study by Thomas and Higbee (2000) examined the correlations between attendance, questionnaire responses, and final grades in algebra and pre-algebra and revealed that:

> Regardless of gender, race, or learning environment, two factors were consistently associated with achievement: attendance and academic autonomy, which reflects students' interest in learning for learning's sake. . . . What makes these findings so important is that so many other variables were examined, yet it was attendance and students' attitude toward being involved in the learning process were [*sic*] the two that emerged as significant to student success (p. 229).

These findings are right in line with Schwartz's (2006) assertion that to achieve success in mathematics, class attendance is a critical but not exclusive requirement. Schwartz contends that seeking outside assistance, either by visiting a tutoring center or accessing faculty office hours, is necessary. Such outside assistance may, in turn, support the other two requirements for mathematics success cited by Schwartz: analyzing written course materials and completing homework problems.

Several researchers have found that students' attitudes toward learning can be positively influenced through peer tutoring. Berry (2002) describes a program in which elementary school children who were paired with older students for assistance with mathematics and reading skills development exhibited increased motivation and positive changes in their study habits. Fotoples (2000) argues that peer tutoring can be a successful tool in alleviating math anxiety, a common challenge faced by students of all ages, at all levels of learning.

As a developmental mathematics educator and Math Resource Center Coordinator at Alverno College, I am interested in examining the factors that motivate or encourage developmental mathematics students to seek widely available assistance with their coursework. Specifically, I am interested in identifying factors that correlate with student use of the Math Resource Center (MRC), an on-campus, drop-in center offering peer tutoring in mathematics. This article explains a statistical examination of such factors.

Method

Research Questions

It is critical to consciously avoid generalizations and assumptions about developmental mathematics students, both on my own campus and on

college campuses across the United States. Students arrive in our classrooms with a medley of life experiences, goals, and time constraints, linked to a variety of advisors and support programs. While such diversity is certainly a cause for celebration, it can complicate even the most well intentioned learning center outreach efforts. If learning assistance centers could somehow focus outreach efforts toward students who might not otherwise pay a visit, learning center coordinators could fulfill the old adage of working smarter, not harder.

This goal leads directly to three research questions. First, can learning center professionals predict which students are likely to visit learning centers? Second, how do factors such as the age and prior college experience of the student, confidence level and perceived importance of mathematics, current course enrollment and enrollment history correlate with use of a mathematics learning center? Third, are there interaction effects between any of these variables?

Data Collection and Analysis

To address these research questions, a ten-question survey was distributed to all developmental mathematics students at Alverno College in Spring of 2006. A total of 527 surveys were distributed to the 12 teachers of 35 course sections, based upon initial enrollment numbers. Teachers administered these surveys during class in all 35 sections. A total of 364 surveys were returned, representing more than a 69% response rate. If unofficial withdrawals and official course drops completed by students between the initial enrollment date and the survey response date could be reasonably quantified, the response rate would likely be even higher.

Initially, six simple analysis of variance (ANOVA) tests were conducted to examine possible correlations between mathematics learning center visits and six parameters individually. Based upon anecdotal experience, students often do not remember the exact number of times they have visited the learning center. Because of this, students were asked to categorize their math learning center visits from 1 ("I never visit the MRC") to 6 ("I visit the MRC 10+ times per semester"). This range of mathematics learning center visits was compared to parameters including the respondents' number of years completed at Alverno College, years since high school graduation, mathematics confidence level, current mathematics course, number of completed college mathematics courses, and perceived importance of mathematics.

Next, a two-way univariate analysis of variance (ANOVA) tests was conducted to examine the number of mathematics learning center visits in relation to both students' mathematics confidence and high school graduation year. Students' responses to the question, "How would you rate your confidence using mathematics?" were divided into three groups. The first confidence group (N=8) included all responses of 1 (never confident) and 2 (seldom confident). The second confidence group (N=40) included all responses of 3 (sometimes confident). The third confidence group (N=293) included all responses of 4 (often confident) and 5 (always confident). Students' high school graduation years were divided into two groups. The first year group (N = 159) included all high school graduation years prior to and including 2002. The second year group (N = 182) included all high

school graduation years since 2002.

Finally, a two-way univariate ANOVA was conducted to examine the number of mathematics learning center visits in relation to both students' reported mathematics confidence and the number of years enrolled at Alverno College. Students' responses to the question, "How would you rate your confidence using mathematics?" were divided into three groups as described above. The first confidence group (N = 8) included all responses of 1 (never confident) and 2 (seldom confident). The second confidence group (N = 40) included all responses of 3 (sometimes confident). The third confidence group (N = 305) included all responses of 4 (often confident) and 5 (always confident). Students' responses to the question, "Including this year, for how many years have you attended Alverno College?" were divided into three groups. The first group included first-year students (N=282), the second group included second-year students (N=48), and the third group (N=23) included students enrolled for three or more years.

Several assumptions were made in designing these tests. First, the number of reported MRC visits was assumed to be normally distributed within each cell. Second, population variances among survey respondents within each group were assumed to be identical. The null hypotheses for the one-way ANOVAs were that there are no statistically significant correlations between Math Resource Center visits and any of the six variables surveyed. The null hypothesis for first two-way ANOVA test was that there is no statistically significant difference in the number of Math Resource Center visits based upon either students' reported confidence using mathematics or their high school graduation year. The null hypothesis for the second two-way ANOVA was that there is no statistically significant difference in the number of Math Resource Center visits based upon either students' reported confidence using mathematics or their number of years enrolled at the college.

Results

Statistics obtained via each one-way ANOVA are shown in Table 1.

Table 1

Reported MRC Visits Compared Individually to Six Variables

Variable	Effect	Sum of Squares	Df	Mean Square	F	Signif-icance
Years at Alverno College	Between groups	18.361	5	3.672	7.539	.000
	Within groups	172.428	354	.487		
	Total	190.789	359			
Years since high school graduation	Between groups	4.241	1	4.241	8.580	.004
	Within groups	171.035	346	.494		
	Total	175.276	347			

Table 1 Continued

Variable	Effect	Sum of Squares	Df	Mean Square	F	Signif-icance
Mathematics confidence	Between groups	5.586	1	5.586	10.845	.001
	Within groups	182.355	354	.515		
	Total	187.941	355			
Current mathematics course	Between groups	.990	2	.495	.932	.395
	Within groups	182.717	344	.531		
	Total	183.706	346			
Mathematics courses completed	Between groups	6.776	3	2.259	4.373	.005
	Within groups	184.365	357	.516		
	Total	191.141	360			
Perceived importance of mathematics	Between groups	1.874	2	.937	1.773	.171
	Within groups	189.267	358	.529		
	Total	191.141	360			

As depicted by significance values, there are statistically significant correlations between the number of math learning center visits and the following variables individually: years at Alverno College, years since high school graduation, mathematics confidence, and the number of mathematics courses completed. In these four instances, the null hypotheses were rejected. Significant correlations do not exist, however, between the number of math learning center visits and either students' current mathematics courses or their perceived importance of mathematics.

Statistics obtained via a two-way ANOVA with math learning center visits as the dependent variable and both mathematics confidence and years since high school graduation as independent variables are presented in Table 2.

As this data reveals, there is little if any effect between mathematics confidence and years since high school graduation with respect to math learning center visits ($\rho > 0.05$).

Table 2

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	Df	Mean Square	F	Significance
Corrected model	7.394[a]	5	1.479	3.014	.011
Intercept	112.244	1	112.244	228.770	.000
Years since HS graduation	.840	1	.840	1.711	.192
Mathematics confidence	3.321	2	1.660	3.384	.035
Years since HS graduation * Mathematics Confidence	.165	2	.082	.168	.846
Error	164.366	335	.491		
Total	839.000	341			
Corrected Total	171.760	340			
[a] R Squared = .043					

Statistics obtained via a two-way ANOVA with math learning center visits as the dependent variable and both mathematics confidence and years enrolled at Alverno College as independent variables are presented in Table 3. As this data reveals, there is a correlation between mathematics confidence and learning center visits (ρ=.014), and there is also a correlation between years of enrollment and learning center visits (ρ=.001). Even more interesting, there is an interaction effect between mathematics confidence and years of enrollment (ρ=.022). The null hypothesis, in this case, is rejected.

Table 3

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected model	19.266[a]	8	2.408	4.931	.000
Intercept	125.973	1	125.973	257.957	.000
Years enrolled at Alverno College	6.530	2	3.265	6.686	.001
Mathematics confidence	4.220	2	2.110	4.321	.014
Years enrolled at Alverno College * Mathematics Confidence	5.685	4	1.421	2.910	.022
Error	167.992	344	.488		
Total	887.000	353			
Corrected Total	187.258	352			
[a] R Squared = .103					

Discussion

The variables significantly correlated with mathematics learning center visits are interesting, as are the variables *not* correlated with use of the learning center. Consider the finding that students who graduated from high school more than five years ago are more likely to visit the mathematics learning center than students who graduated from high school within the last five years. This statistical finding may suggest that life experience leads students to access academic support services more readily than less experienced peers. Indeed, research has shown that interactive learning experiences including peer tutoring sessions pair well with the experiential learning methods preferred by many adults (Lawrence, 1988).

The impact of experience may also account for the finding that the number of college mathematics courses completed is significantly correlated with mathematics learning center visits, while there is no significant correlation between students' current mathematics courses and their use of the learning center. Apparently, accrued mathematics experience is a more significant factor in deciding on academic support than a student's current mathematics course itself.

Not surprisingly, students with three or more years of enrollment at the college are more likely to visit the mathematics learning center than first-year or second-year students. As all students enrolled in a developmental mathematics course at Alverno College receive information about the math learning center directly from their course instructors, this disparity cannot be attributed to lack of knowledge about the facility. Rather, the data might suggest that students with looming graduation dates are more willing to access academic support than students for whom graduation is a distant vision. More surprising is the finding that students' perceived importance of mathematics is not significantly correlated with mathematics learning center visits. Might this suggest that students are focused upon graduation as the end goal, rather than their post-graduation aspirations? A follow-up study could potentially investigate this question.

The finding that low mathematics confidence is strongly correlated to mathematics learning center visits should make learning center professionals pause. Of course, many learning center professionals hope that all students will access their services and make a particular point of encouraging students who express a lack of confidence to visit their learning centers. However, this correlation suggests that students with high mathematics confidence may, in fact, be avoiding such services. Clearly, the attention of learning center professionals is needed to convey the message that learning centers also welcome *confident* students. On-campus advertising and recruiting efforts should be conducted with this caution in mind, carefully avoiding what may be perceived by savvy students as deficit-model approaches to learning assistance.

The statistics revealed by the two-way univariate ANOVAs become clear when examined graphically. While Figure 1 does not indicate an interaction effect, it depicts the correlation between mathematics confidence and learning center visits, as described above. This figure also suggests that older students are more likely to visit the mathematics learning center than younger students with the same mathematics confidence level.

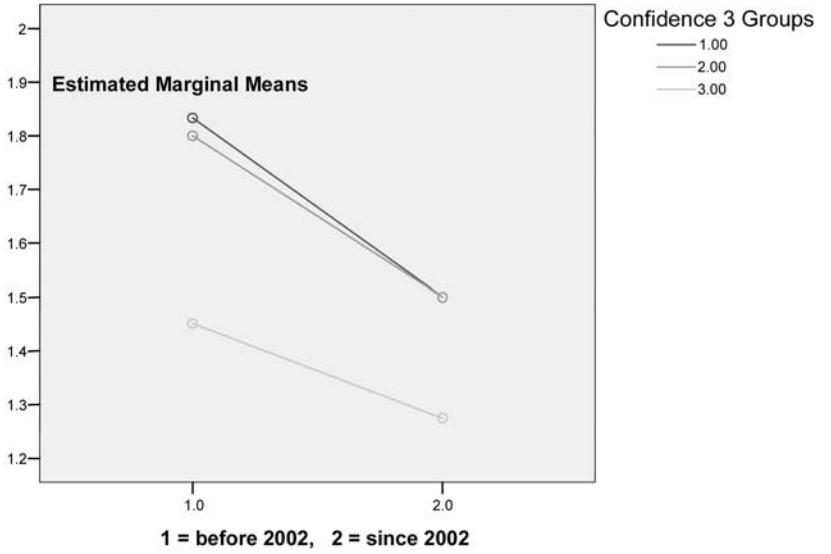

Figure 1. Estimated marginal means of MRC visits: confidence level of active college students

On the other hand, Figure 2 visually confirms the finding that students who completed high school 5 or more years ago are more likely to visit the Math Resource Center than are students who completed high school within the past five years. Also, the data shows that students with lower confidence levels are more likely to visit the Math Resource Center than are students with higher confidence levels, regardless of years elapsed since their high school graduation. The fact that the lines intersect suggests an interaction effect, where a combination of low mathematics confidence and third-year or higher student status correlates strongly with use of the mathematics learning center.

The reality of the intersection between low confidence and upper-class student standing as variables correlated with learning center use offers several implications for learning center professionals. First, it suggests that many students may still view learning centers as venues for receiving deficit-model instruction. Students with low confidence may feel that visiting a learning center is appropriate for "fixing" their math skills, whereas students with high confidence may avoid learning centers out of a belief that their mathematical understanding doesn't need "repair." Second, these findings imply that many students view learning centers as facilities for serving discrete and immediate needs, rather than as facilities for developing broad and long-term skills. Students with three or more years of college attendance are likely much closer to graduation than their less experienced peers, provided that they successfully complete their general mathematics requirements. Students with upper-class standing, then, may be driven by a sense of urgency rather than by refined study habits to visit the learning center.

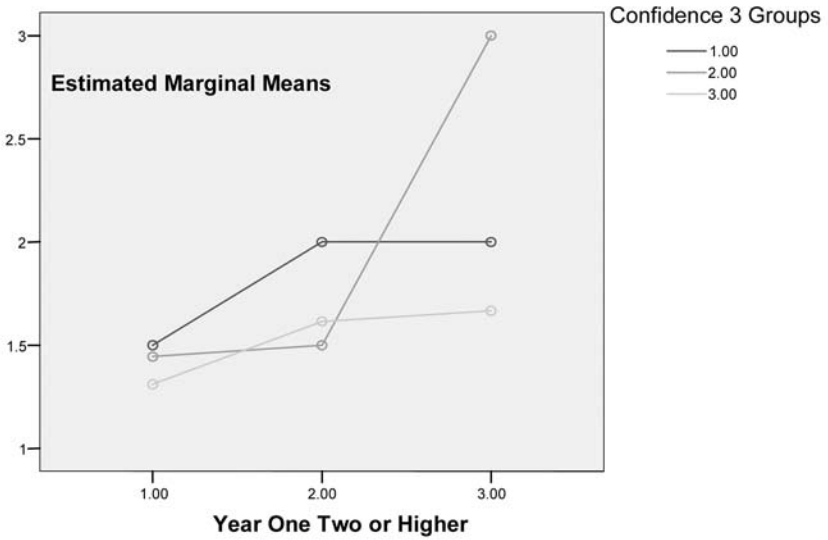

Figure 2. Estimated marginal means of MRC visits: confidence level of entering students

These findings are not surprising. The Math Resource Center has long battled the "stigma" within the student body that the center serves only developmental students. Despite the fact that the Math Resource Center serves students across the mathematics curriculum of the college and is serving higher numbers of upper-level mathematics students now than it ever has, younger students still seem to connect accessing academic services with admitting deficiencies. It may be that younger students have a more exaggerated sense of confidence in developmental mathematics courses than do returning adults. In the teaching experience of the author, younger students are less likely to sense the early stages of academic difficulties than are older students. Older students, in contrast, seek these services more eagerly. Ironically, the ability of older students to sense these difficulties quickly may contribute to both their willingness to seek academic assistance and to their lower confidence levels.

Conclusion

The effect of experience, including academic experience specifically and life experience in general, on students' willingness to seek academic support warrants further exploration. A future study into the relationship between life experience, academic experience, and use of academic support services might lead to findings useful to learning center professionals and mentoring program directors.

Meanwhile, this study serves as a reminder that learning center professionals should remain diligent in reaching out to the youngest, least experienced students. Learning center professionals might consider seeking ways to help the student populations on their campuses temper their often high confidence and develop solid academic skills. All students stand to

benefit from accessing academic support services. Hopefully, by sharing research and practice with one another, learning center professionals can find new ways to draw in these students.

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